

Preblessing  
Gap-X-Gap studies  
for  $\sqrt{s} = 1960\text{GeV}, 900\text{GeV}, 300\text{GeV}$   
 $X = 2$  hadrons

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- Gap cuts
- Exclusivity cuts
- 2 Exclusive tracks on primary vertex
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# Data sample

- Datasets used:
  - gdifap – 1960 GeV
  - gdifar – 900/300 GeV
- Same trigger requirement:  
**DIFF\_TWO\_CJET0.5\_PLUGVETO\_0.75**
  - 2 central ( $|\eta| < 1.32$ ) towers with  $E_t > 0.5$  GeV
  - Plug ( $2.11 < |\eta| < 3.64$ ) in veto ( $E_t < 0.75$  GeV)
  - BSC1 and CLC in veto
- $L = 7.12/\text{pb}$  – 1960 GeV and  $L = 0.074/\text{pb}$  – 900 GeV
- Gaps at least from  $|\eta| = 1.3$  to  $|\eta| = 5.9$

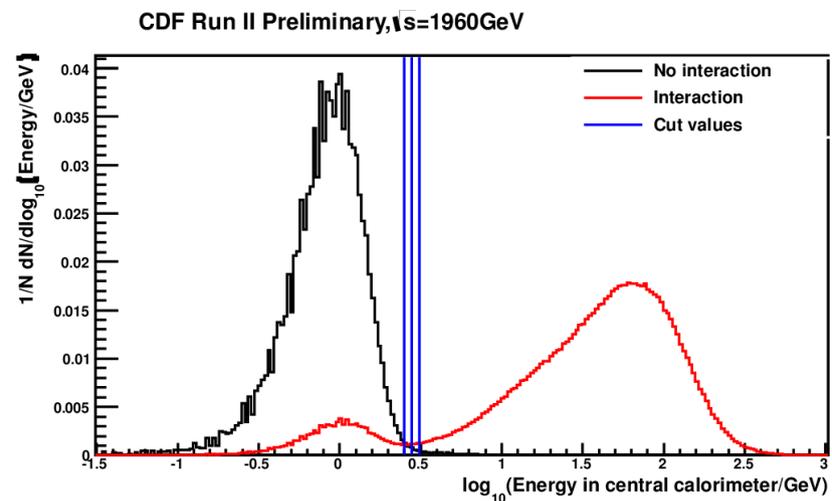
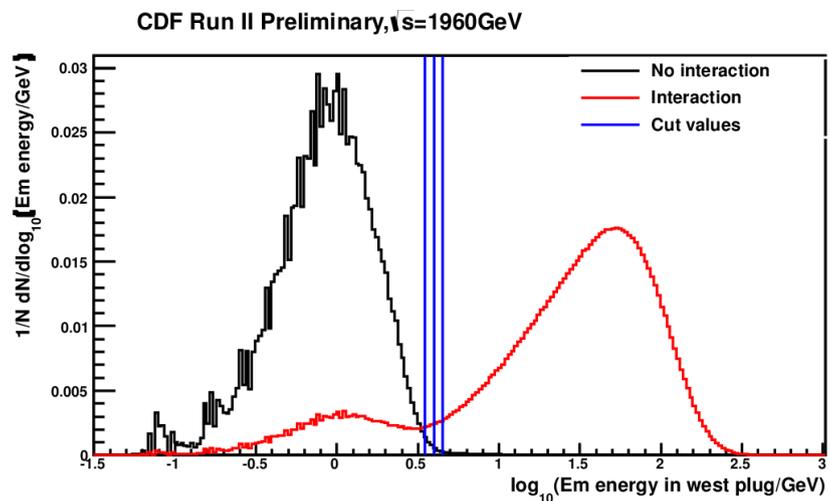
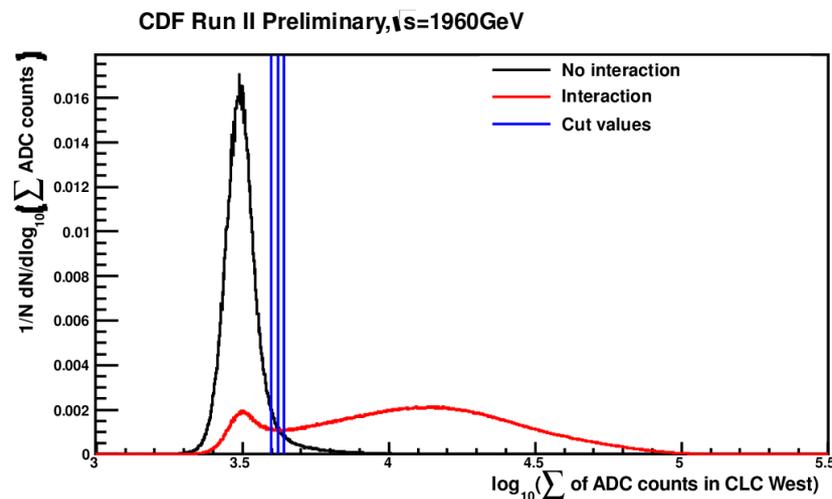
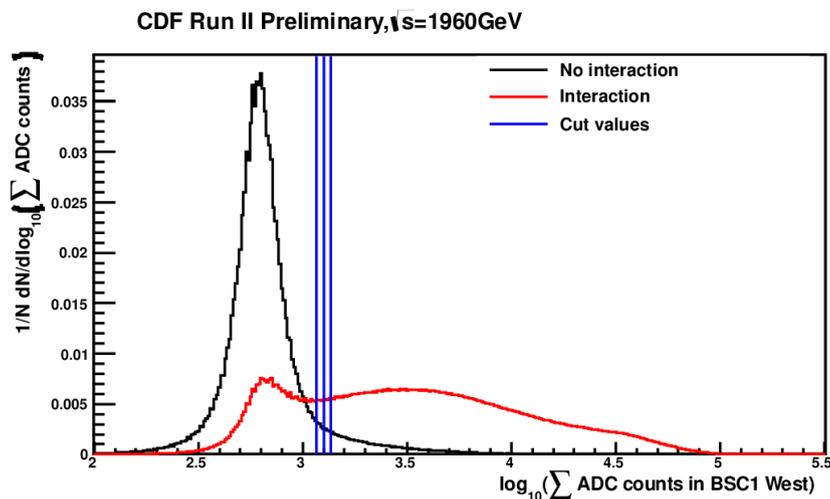
# Gap cuts – idea

- To determine noise levels in sub-detectors we divide zero-bias sample from same periods into two sub-samples:
  - No Interaction:
    - No tracks
    - No CLC hits
    - No muon stubs
  - Interaction:
    - Opposite

# Exclusivity cuts in central region

- To determine exclusive 2-4 tracks we apply similar technique in central region, excluding cones of radius 0.3 in eta-phi space around each track extrapolation.

# Example distributions

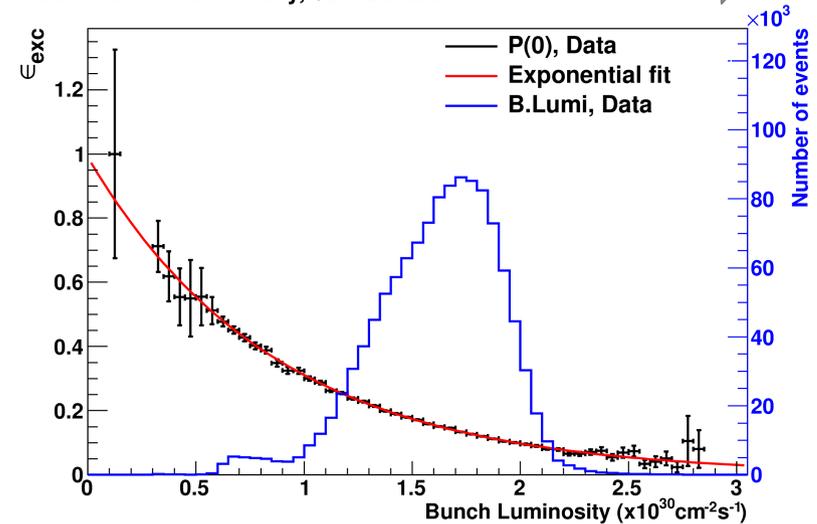


# Effective exclusive luminosity

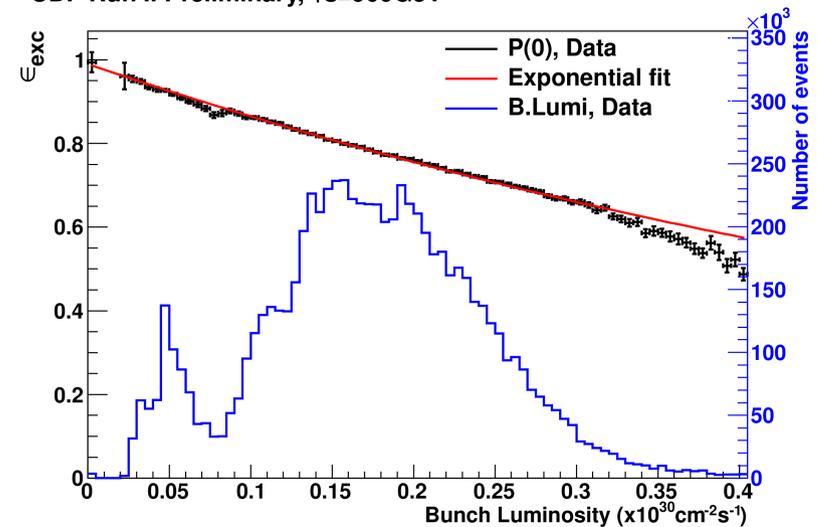
Bless

- We determine efficiency of having no-pileup using zero-bias sample. We measure ratio of empty events (all detectors on noise level) to all events.
- Should drop exponentially with bunch luminosity and be equal 1 at  $L=0$  (0.990 from both fits). Slope corresponds to total inelastic cross section:
  - 53.88 mb – 1960 GeV
  - 62.76 mb – 900 GeV
- Effective luminosities:
  - 1.18/pb – 1960 GeV
  - 0.059/pb – 900 GeV

CDF Run II Preliminary,  $\sqrt{s}=1960\text{GeV}$



CDF Run II Preliminary,  $\sqrt{s}=900\text{GeV}$



# Additional 2 tracks cuts - overview

Cosmics cuts – no muons, 3D opening angle, d0

Quality cuts – d0, dZ0, N of COT hits,  $\chi^2/N_{\text{dof}}$ ,  $p_T$

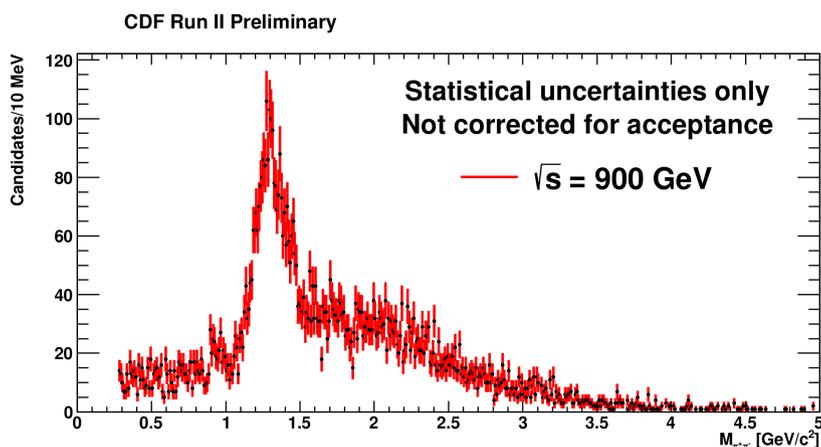
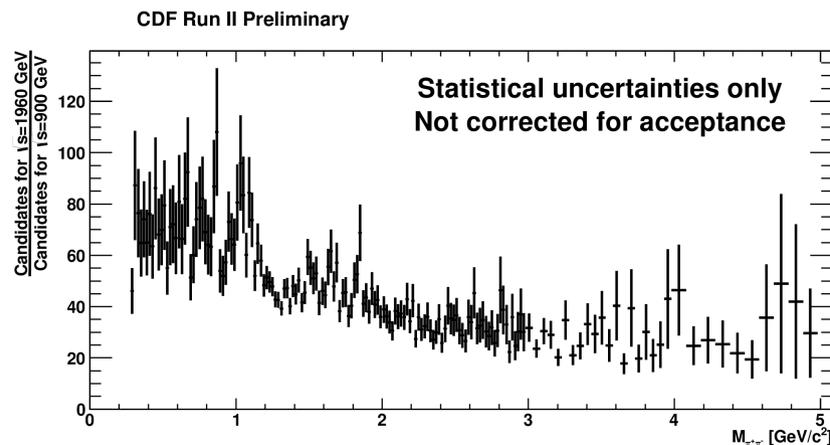
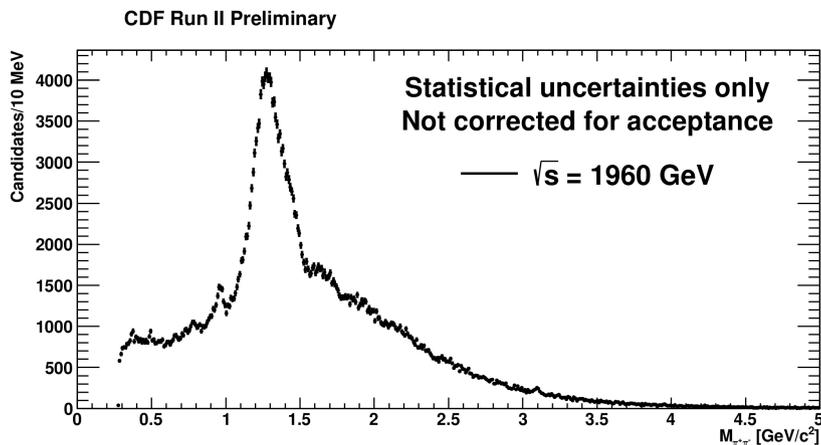
Trigger matching

Physics – eta, rapidity of central state,  
total charge

# Numbers of events after cuts

Number of events	1960GeV	900GeV
Triggered	92130 x 10 <sup>3</sup>	21737 x 10 <sup>3</sup>
Forward cleanup	59276 x 10 <sup>3</sup>	18749 x 10 <sup>3</sup>
2 tracks	4700 x 10 <sup>3</sup>	271 x 10 <sup>3</sup>
Quality + cosmic rejection + exclusivity	415413	8400
Opposite sign	350009	7595
Luminosity	7.12/pb	0.074/pb
Exclusive luminosity	1.18/pb	0.059/pb

# Invariant mass – no corrections



# Trigger efficiency:

1. Select min-bias data, good quality isolated (no other tracks in cone with  $r=0.4$ ) tracks.
2. Check how often they fired 0, 1, 2 or more trigger towers ( $\geq 4$  bits) in  $3 \times 3$  box around track extrapolation.
3. Trigger efficiency composed from those 3 probability functions, each fitted with polynomials in 3 subranges.

$$\text{Eff} = P_2(\text{pt1}) + P_1(\text{pt1}) * (P_1(\text{pt2}) + P_2(\text{pt2})) + P_0(\text{pt1}) * P_2(\text{pt2})$$

# Acceptance:

## 1. Generation ( $X \rightarrow \pi^+ \pi^-$ )

Flat distribution in rapidity of  $X$  -  $-1.0 - 1.0$

Flat distribution in mass of  $X$  -  $0 - 5.0 \text{ GeV}/c^2$

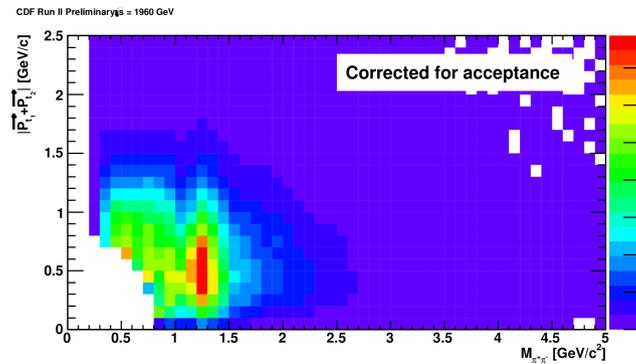
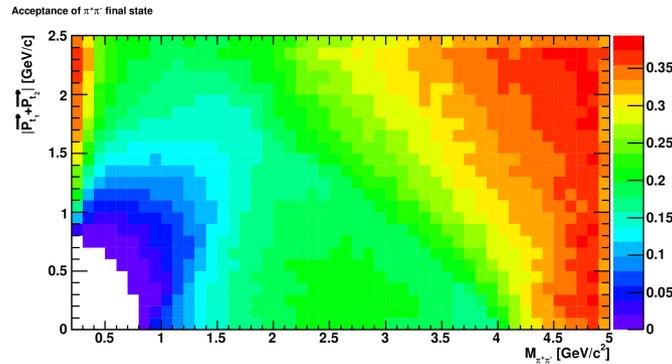
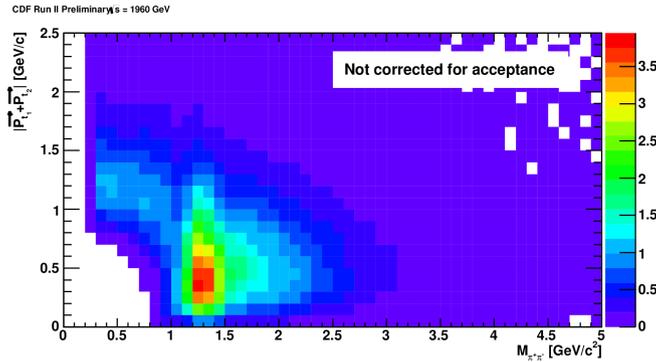
Flat distribution in  $P_t$  of  $X$  -  $0 - 2.5 \text{ GeV}/c$

Decay according to  $J=0$  (S-wave) phase space

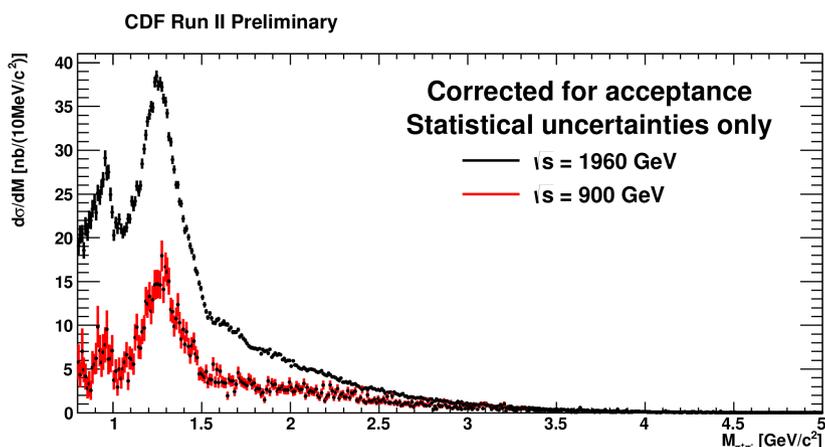
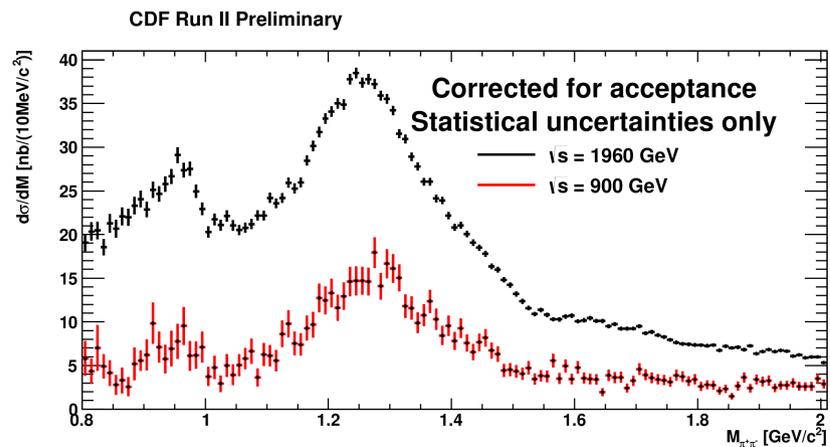
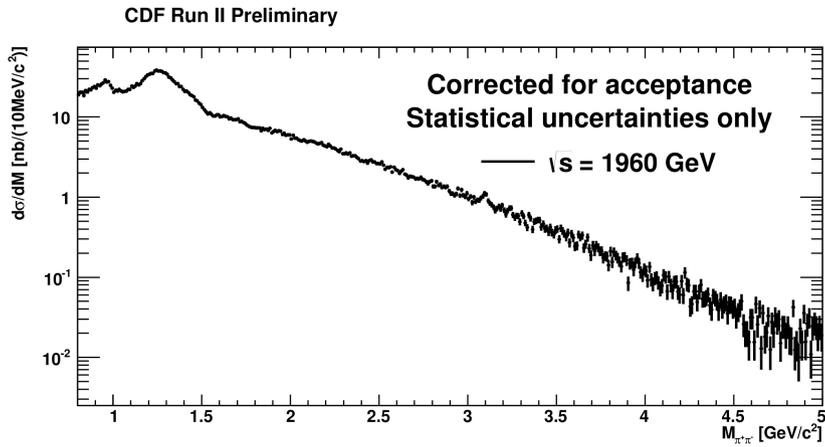
## 2. Detector simulation

## 3. Acceptance calculation

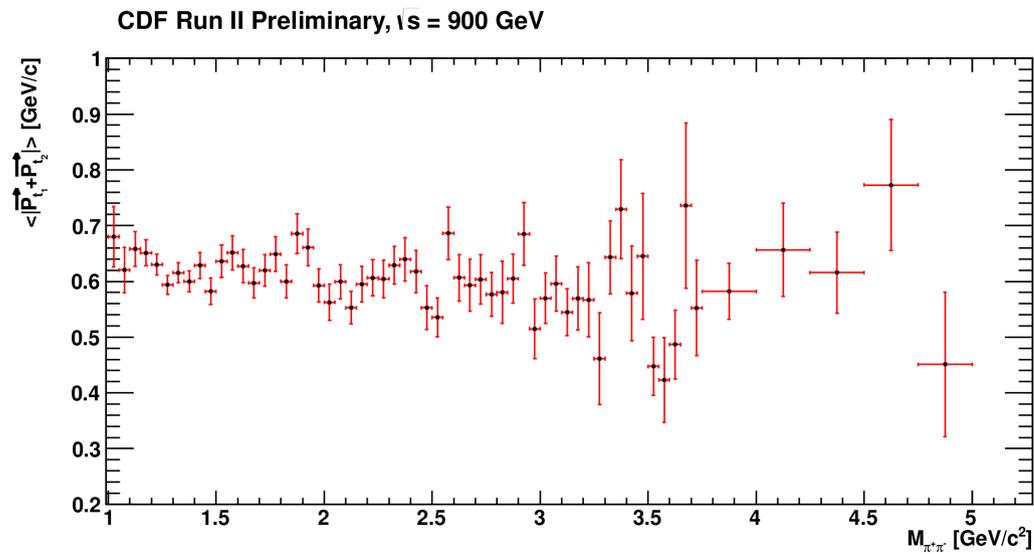
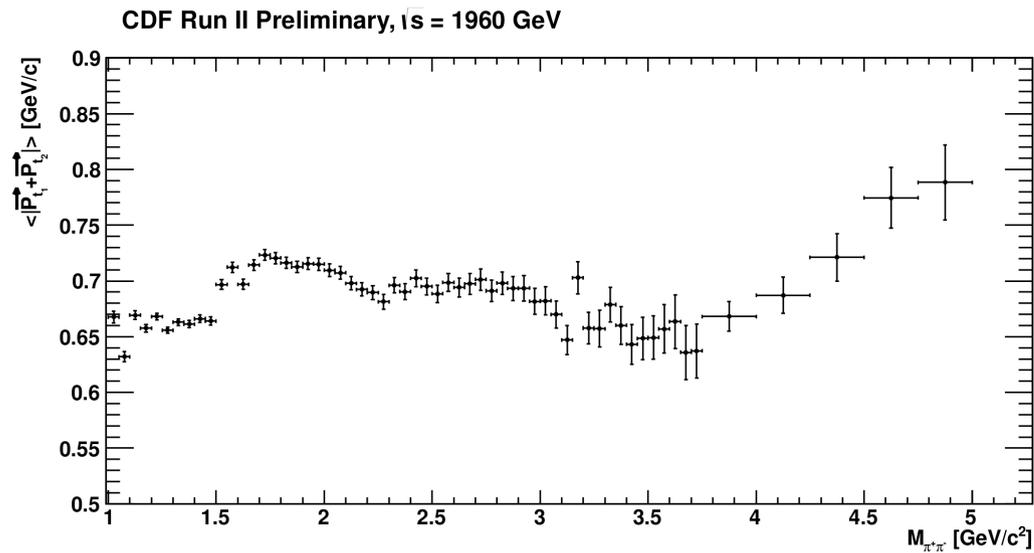
# Invariant mass vs $p_T$ – corr.



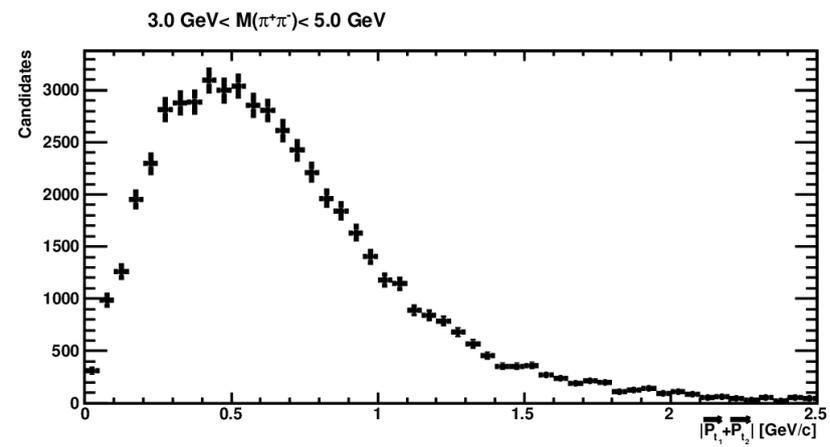
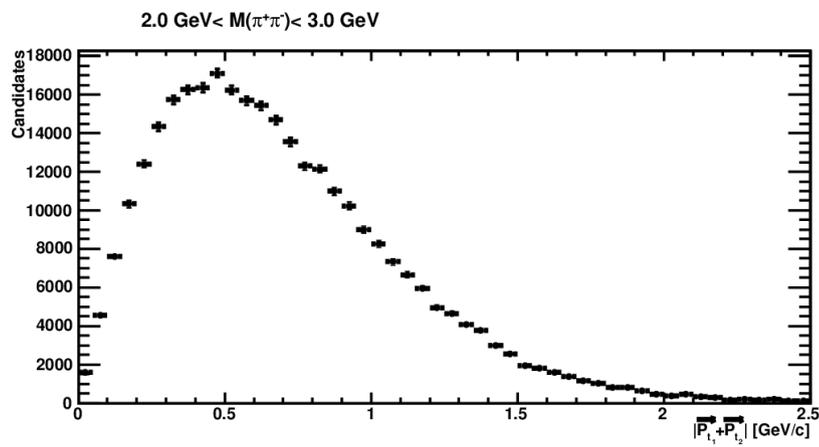
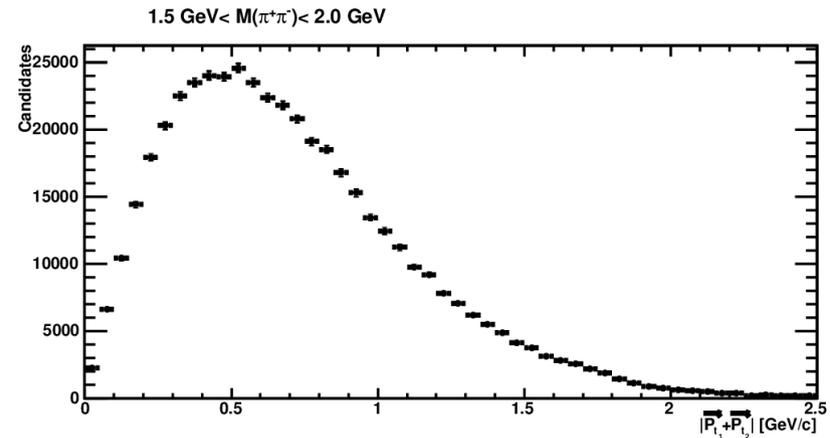
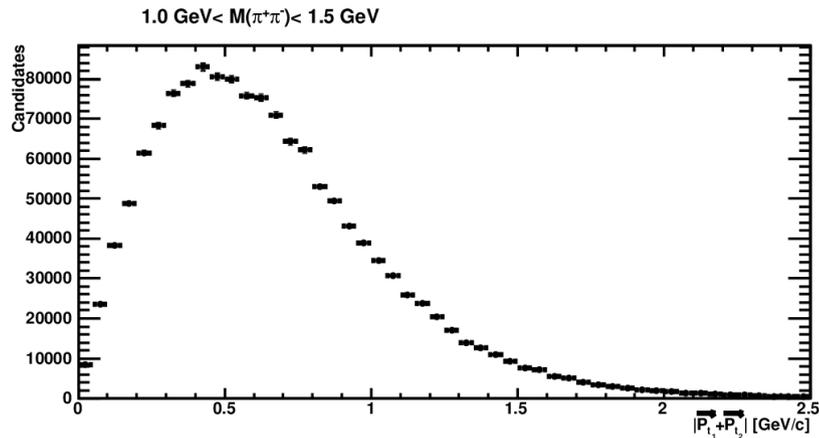
# „Integrated” invariant mass



# Mean $p_T$



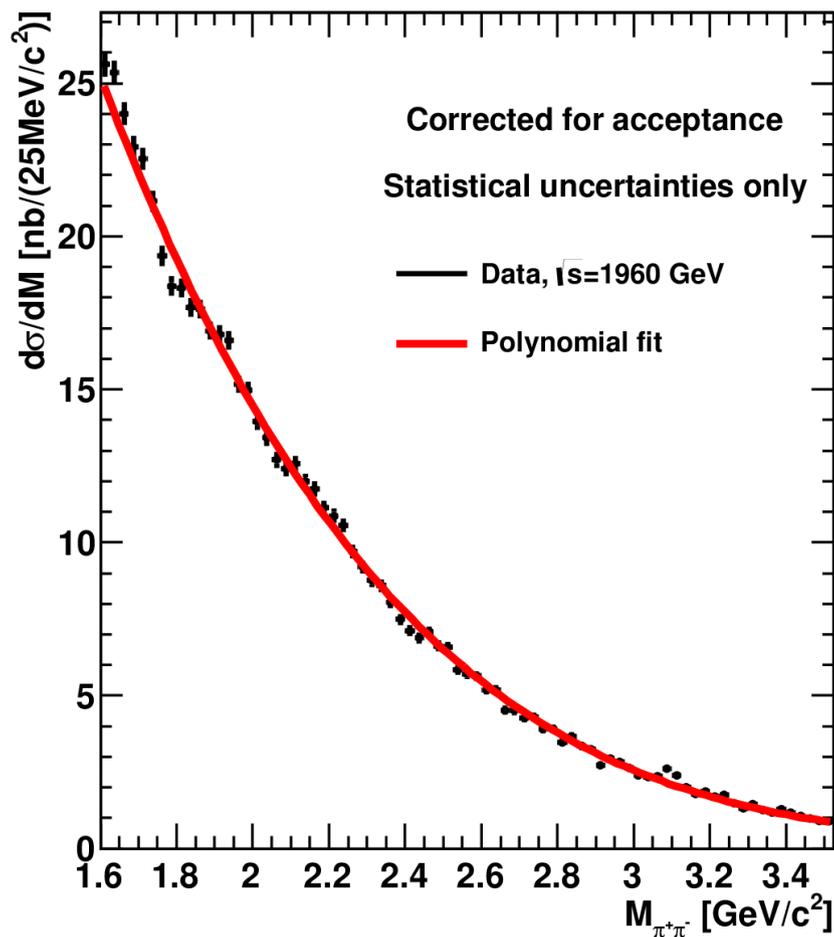
# $p_T$ distributions



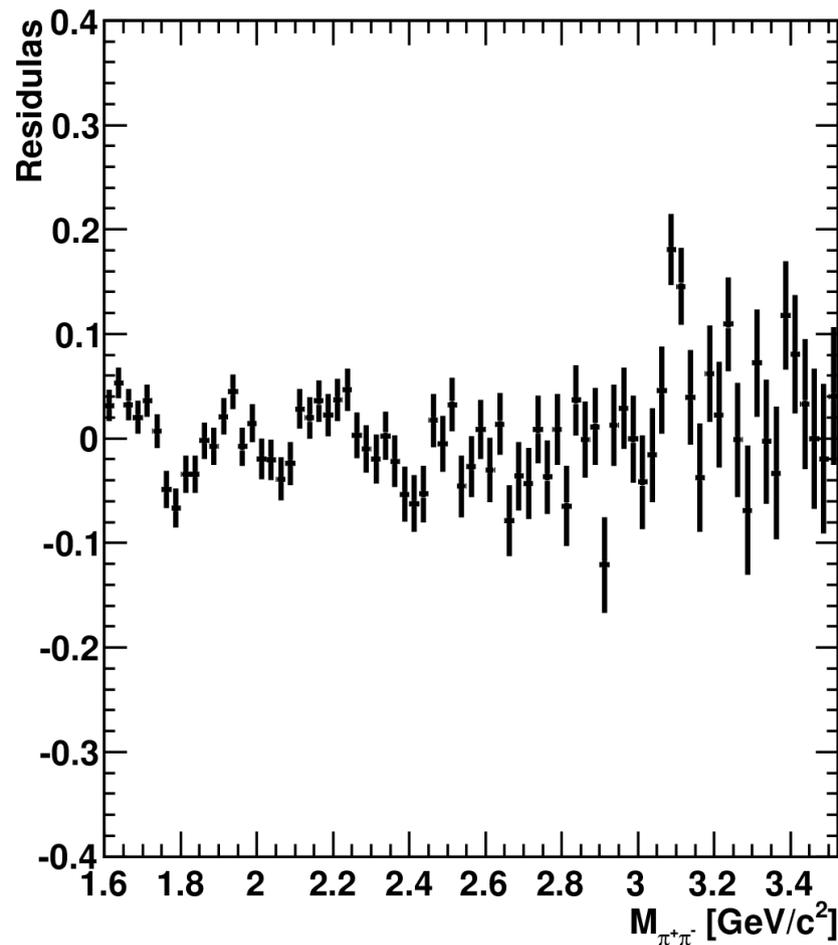


# Tail shape

CDF Run II Preliminary



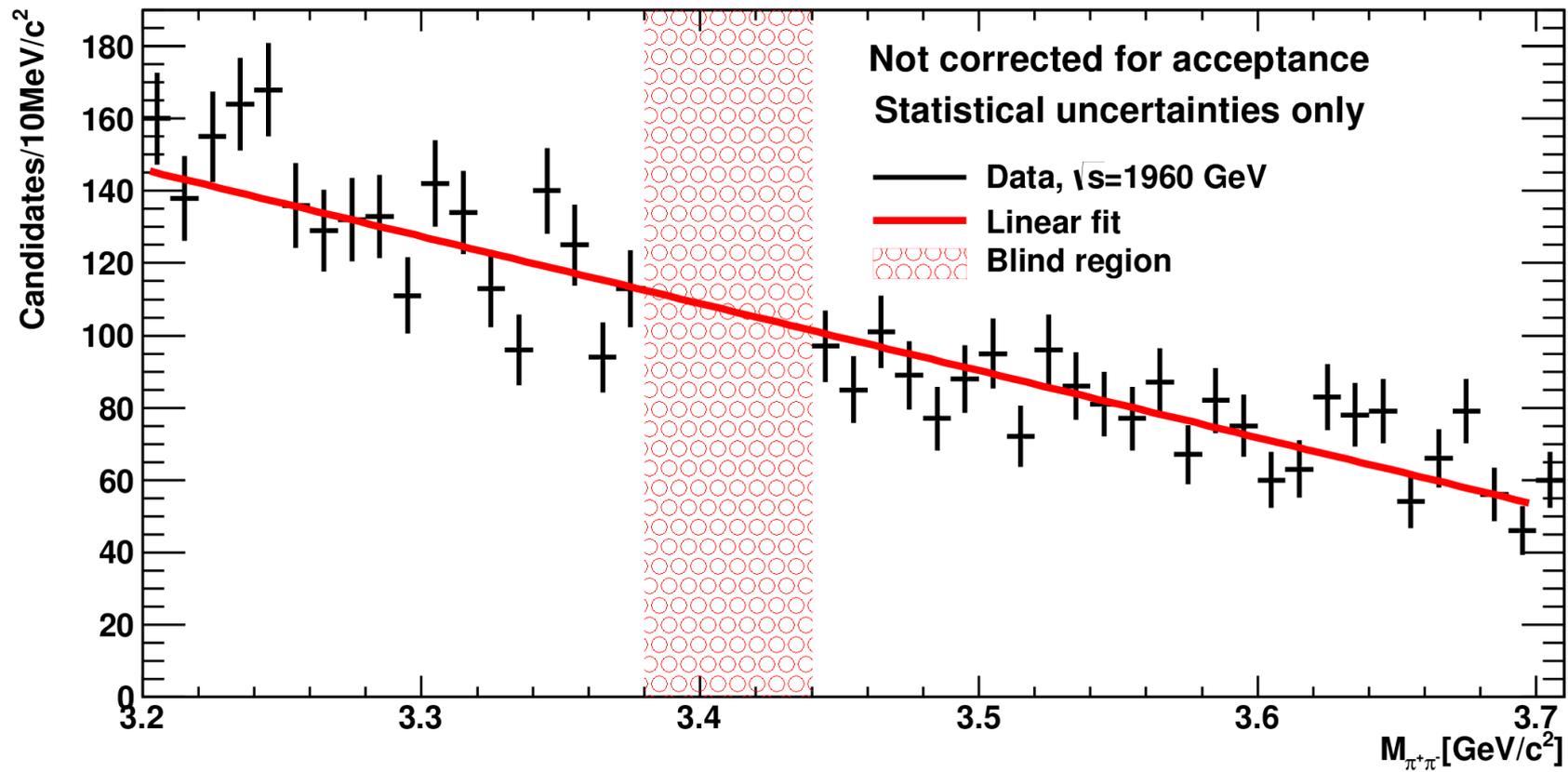
CDF Run II Preliminary



# Chi\_c $\rightarrow$ pi<sup>+</sup>pi<sup>-</sup> region



CDF Run II Preliminary



# Chi\_c $\rightarrow$ pi<sup>+</sup>pi<sup>-</sup> limit



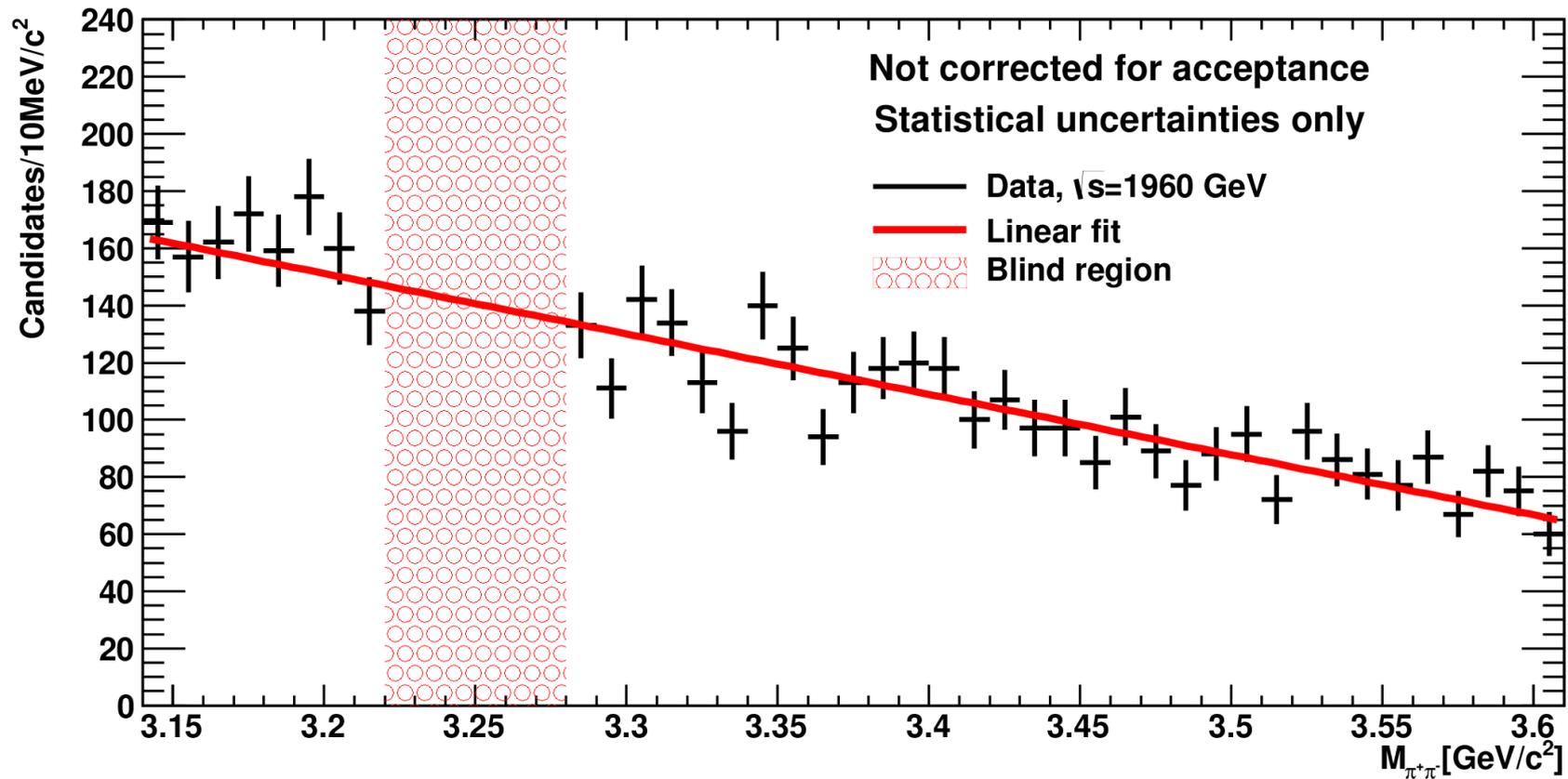
We set 90% upper limit on chi\_c production using the invariant mass distribution, fitting linear background to the sidebands and counting events in +/- 3 sigma window.

Estimated background	641.7	events
Events in window	660	events
Limit	56.3 + 6.7 – 7.2	events
90% (dσ)/(dy) limit	18.4 + 2.2 – 2.1	nb
(25% acceptance)		

# Chi\_c → K<sup>+</sup>K<sup>-</sup> region



CDF Run II Preliminary



# Chi\_c $\rightarrow$ K<sup>+</sup>K<sup>-</sup> limit



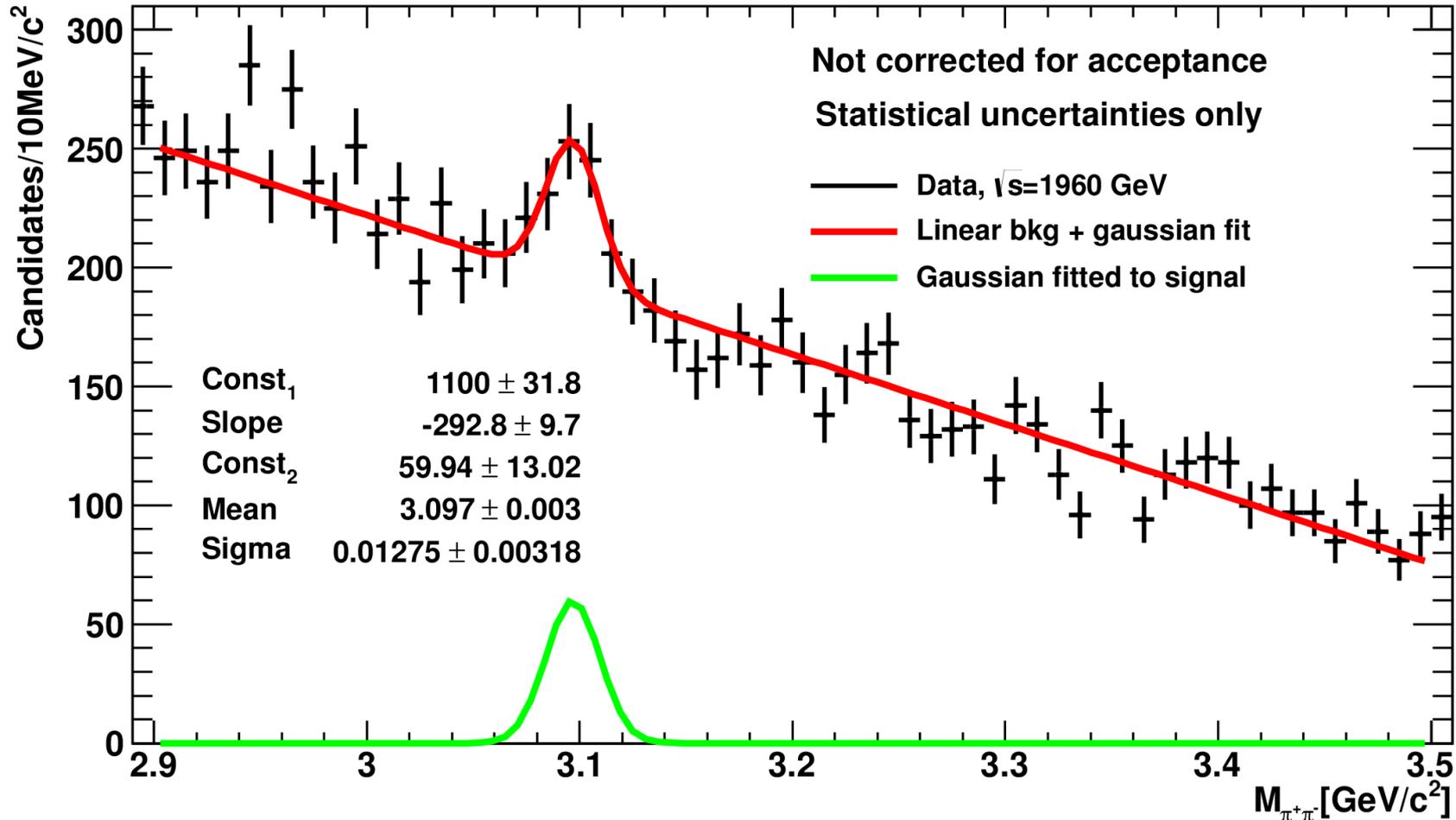
We set 90% upper limit on chi\_c production using the invariant mass distribution, fitting linear background to the sidebands and counting events in +/- 3 sigma window.

Estimated background	843.6	events
Events in window	884	events
Limit	81 + 10 – 12	events
90% (dσ)/(dy) limit	24.5 + 3.2 – 3.6	nb
(25% acceptance)		

# J/psi $\rightarrow$ $e^+ e^-$



CDF Run II Preliminary



# J/psi significance and cross section



Mass is shifted only by few MeV with pion assumptions. Shape not changed

In 3 sigma region of J/psi peak we have

192 (14 stat) (38 syst) signal events

1481 (38 stat) (296 syst) background events

Significance of the peak is  $4.98 \sigma$  (S/sqrt(B))

$(d\sigma)/(dy)$  7.4 (0.5 stat) (1.5 syst) nb

# Systematics - principles

1. All cut parameters varied by
  - ~ 1 standard deviation (gaus-like) or
  - ~ 0.5 of FWHM width (Lorentz like)
  - what looked reasonable (others)
2. Trigger efficiency – fitted polynomials of degree smaller by 1 than in efficiency approximation.
3. Same value of cut for E-W forward detectors.
4. Assumed independence of such systematics.
5. Applied simultaneously in data/MC

# Systematics - summary

1960 GeV

Exclusivity cuts in central calorimeter – 15%

Forward plug cuts – 6.0%

Chi<sup>2</sup> – 3.0%

Z0 – 2.0%

pT – 2.0%

BSC – 2.0%

Luminosity – 6.0%

Total: ~20%, not mass dependent

900 GeV

Exclusivity cuts in central calorimeter – 15%

Forward plug cuts – 6.0%

Chi<sup>2</sup> – 3.0%

Z0 – 4.0%

BSC – 4.0%

PT – 2.0%

Luminosity – 6.0%

Total: ~20%, not mass dependent

Thank you

# Cut values 1960GeV:

Sum of ADC counts in Bsc1 West	< 1260 counts
Sum of ADC counts in Bsc1 East	< 1260 counts
Sum of ADC counts in CLC West	< 4170 counts
Sum of ADC counts in CLC East	< 4170 counts
Sum of Em Energy in West Plug	< 4.0 GeV
Sum of Em Energy in East Plug	< 4.0 GeV
Sum of Had Energy in West Plug	< 4.5 GeV
Sum of Had Energy in East Plug	< 4.5 GeV
Energy in Central Calorimeter:	< 2.8 GeV

# Variations for systematics estimation:

Sum of ADC counts in Bsc1 West:	1160 – 1360 c.
Sum of ADC counts in Bsc1 East:	1160 – 1360 c.
Sum of ADC counts in CLC West:	3970 – 4370 c.
Sum of ADC counts in CLC East:	3970 – 4370 c.
Sum of Em Energy in West Plug:	3.5 – 4.5 GeV
Sum of Em Energy in East Plug:	3.5 – 4.5 GeV
Sum of Had Energy in West Plug:	4.0 – 5.0 GeV
Sum of Had Energy in East Plug:	4.0 – 5.0 GeV
Energy in Central Calorimeter:	2.5 – 3.1 GeV

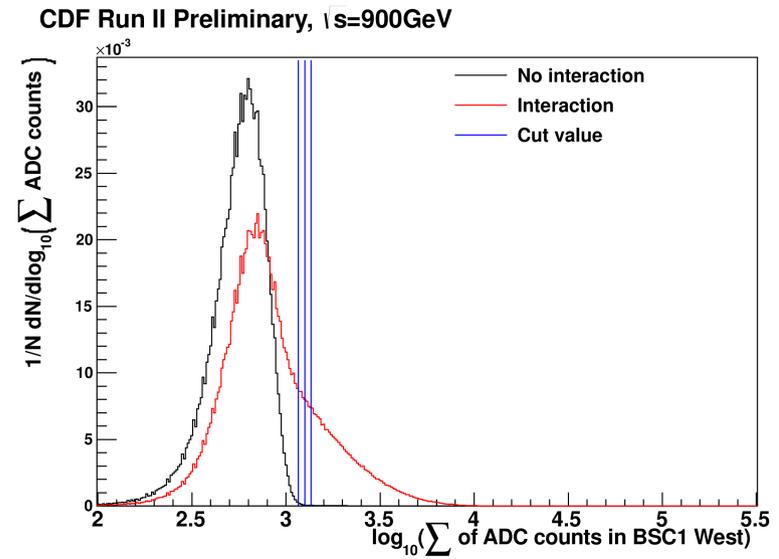
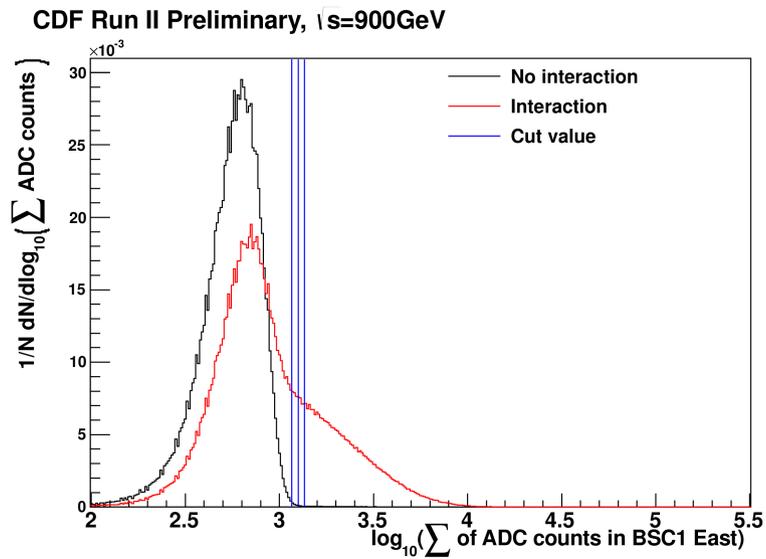
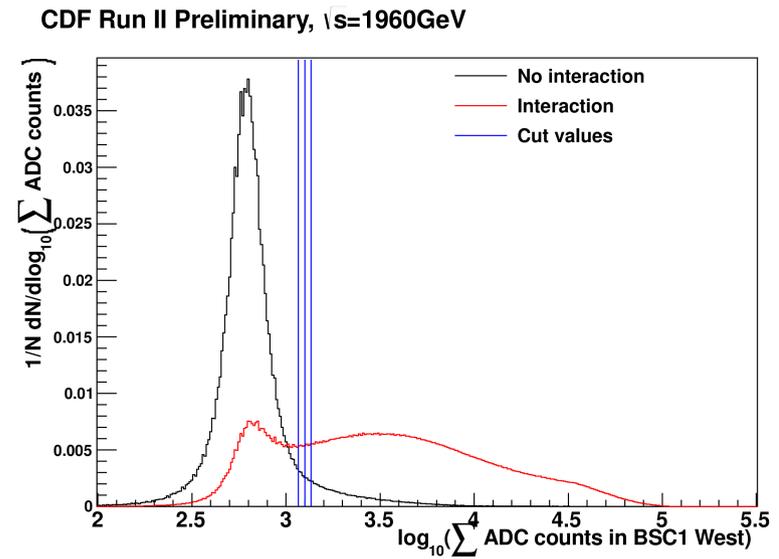
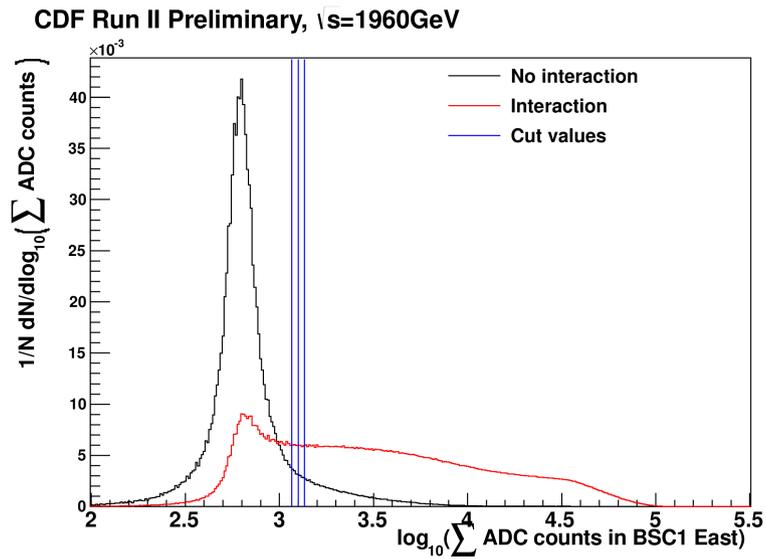
# Cut values 900GeV:

Sum of ADC counts in Bsc1 West	< 1260 counts
Sum of ADC counts in Bsc1 East	< 1260 counts
Sum of ADC counts in CLC West	< 4000 counts
Sum of ADC counts in CLC East	< 4200 counts
Sum of Em Energy in West Plug	< 3.0 GeV
Sum of Em Energy in East Plug	< 3.5 GeV
Sum of Had Energy in West Plug	< 2.1 GeV
Sum of Had Energy in East Plug	< 3.0 GeV
Energy in Central Calorimeter:	< 0.8 GeV

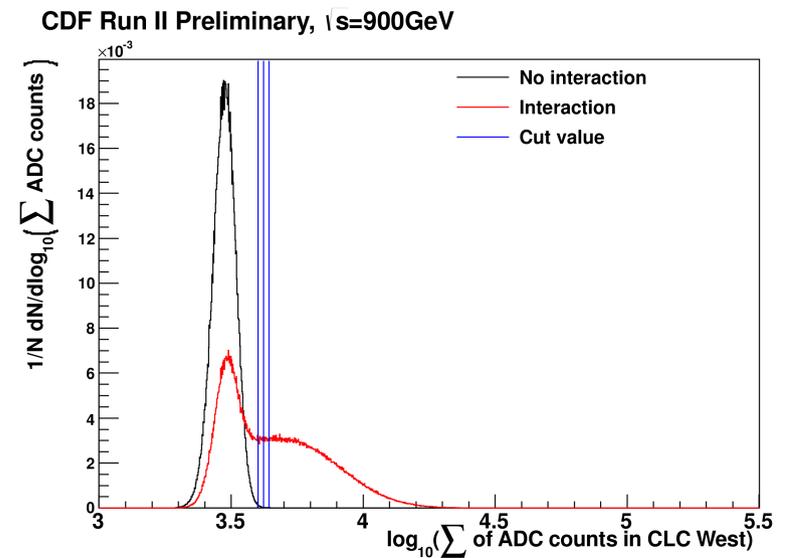
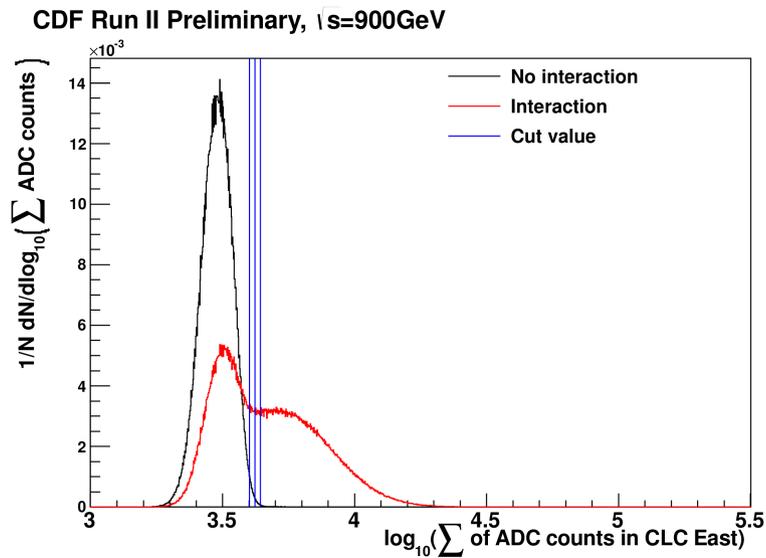
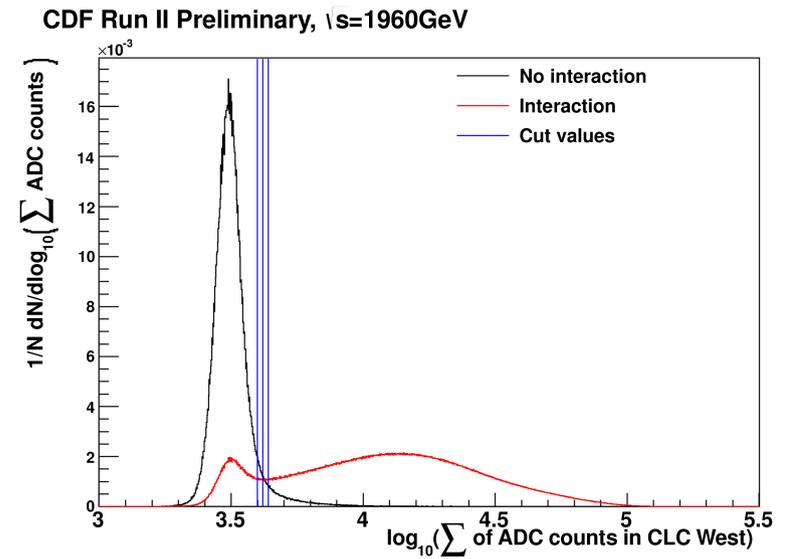
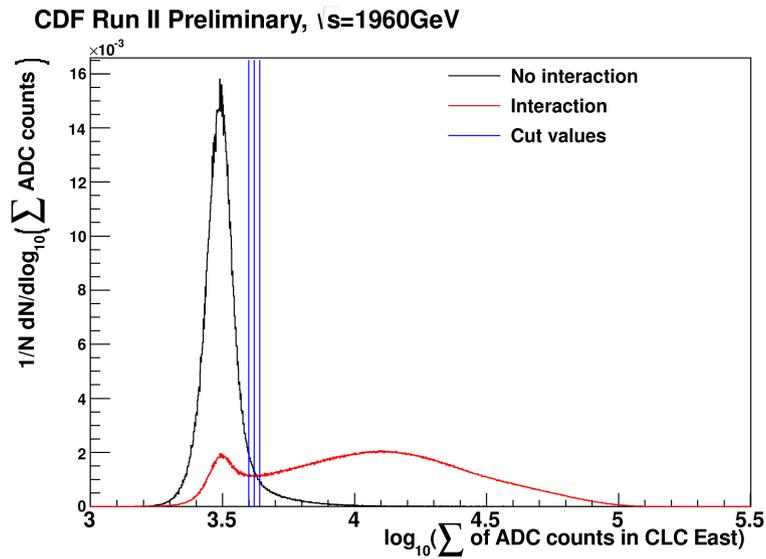
# Variations for systematics estimation:

Sum of ADC counts in Bsc1 West:	1160 – 1360 c.
Sum of ADC counts in Bsc1 East:	1160 – 1360 c.
Sum of ADC counts in CLC West:	3800 – 4200 c.
Sum of ADC counts in CLC East:	4000 – 4400 c.
Sum of Em Energy in West Plug:	2.5 – 3.5 GeV
Sum of Em Energy in East Plug:	3.0 – 4.0 GeV
Sum of Had Energy in West Plug:	1.9 – 2.3 GeV
Sum of Had Energy in East Plug:	2.5 – 3.5 GeV
Energy in Central Calorimeter:	0.6 – 1.0 GeV

# Bsc1

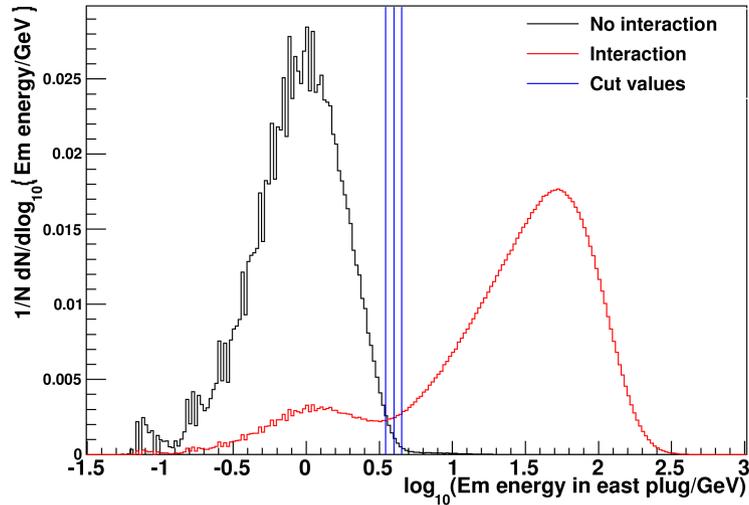


# CLC

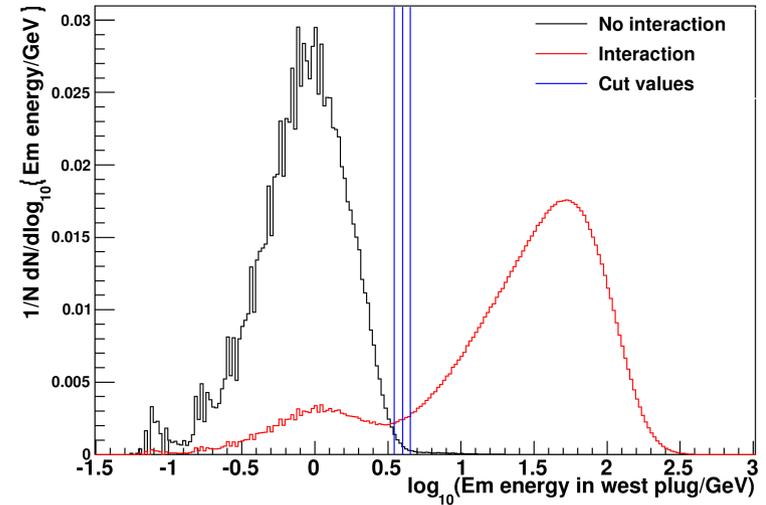


# Forward Plug Em

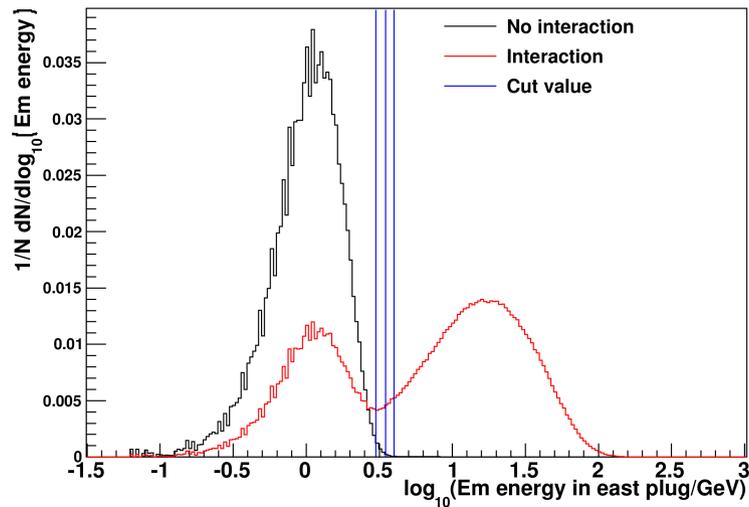
CDF Run II Preliminary,  $\sqrt{s}=1960\text{GeV}$



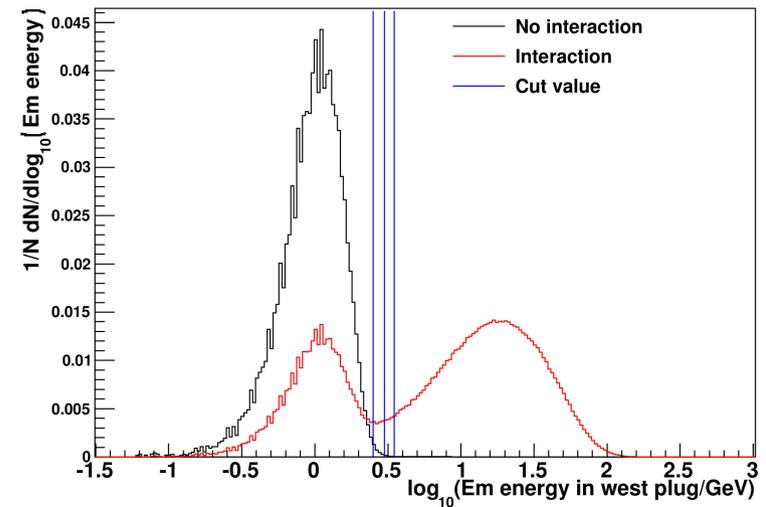
CDF Run II Preliminary,  $\sqrt{s}=1960\text{GeV}$



CDF Run II Preliminary,  $\sqrt{s}=900\text{GeV}$

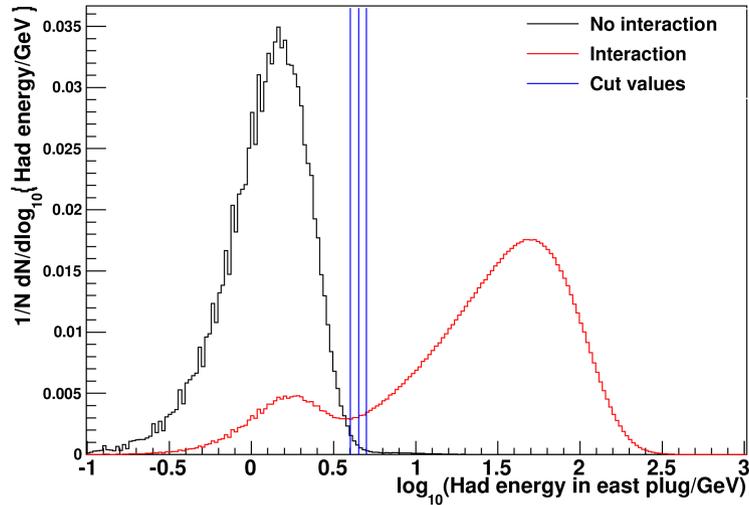


CDF Run II Preliminary,  $\sqrt{s}=900\text{GeV}$

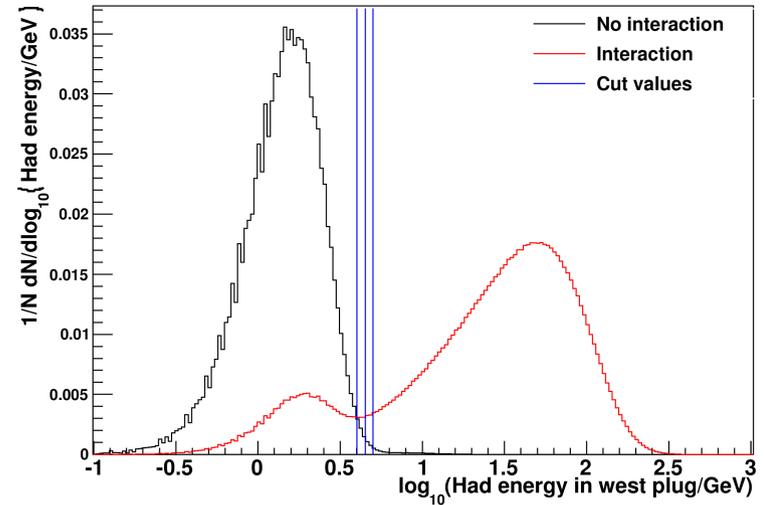


# Forward Plug Had

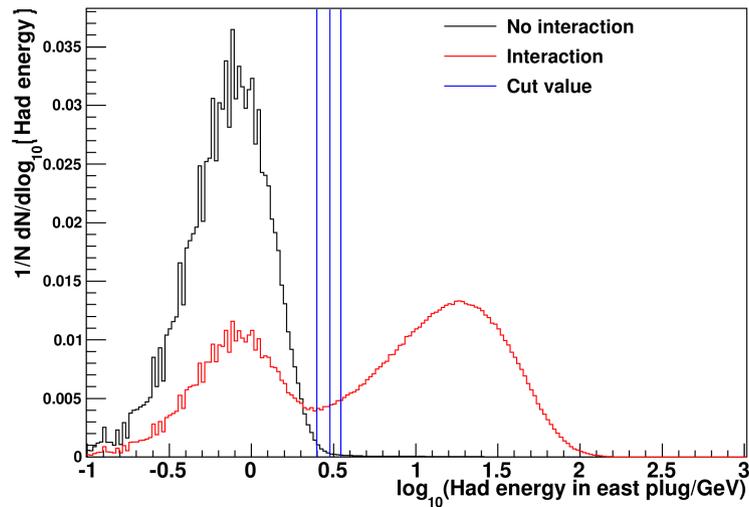
CDF Run II Preliminary,  $\sqrt{s}=1960\text{GeV}$



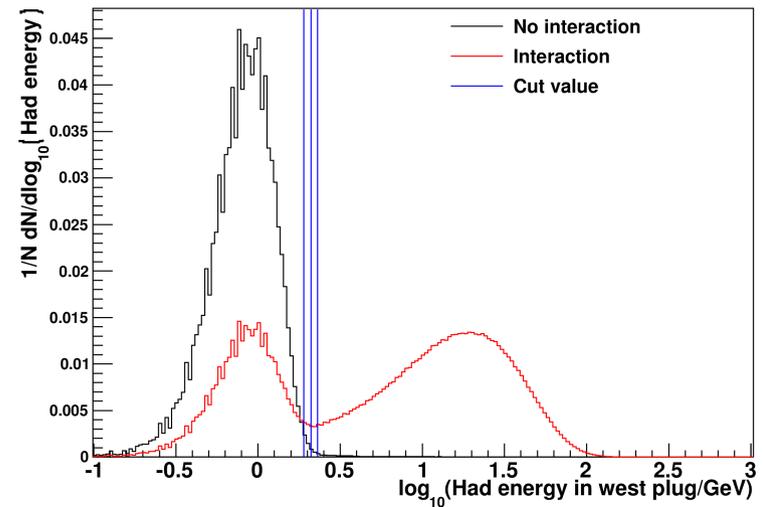
CDF Run II Preliminary,  $\sqrt{s}=1960\text{GeV}$



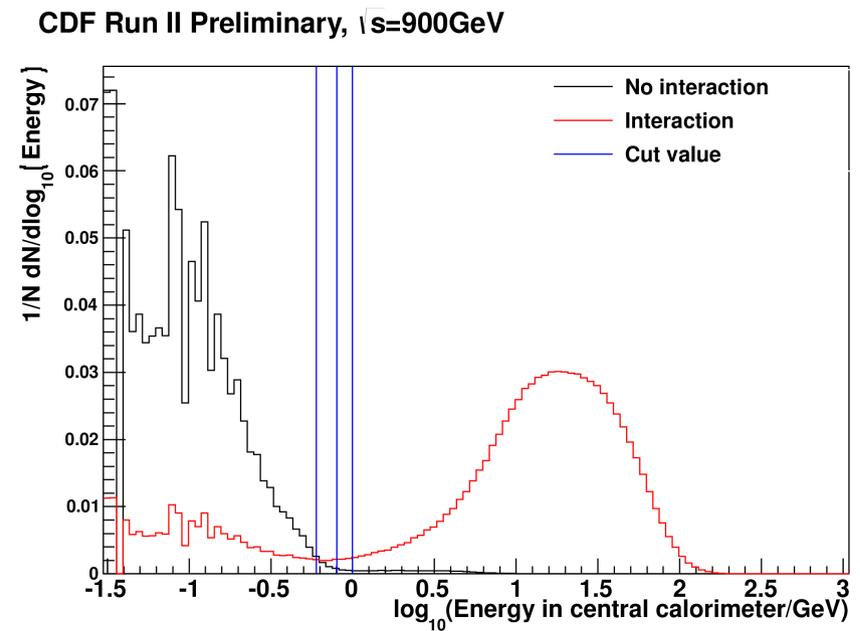
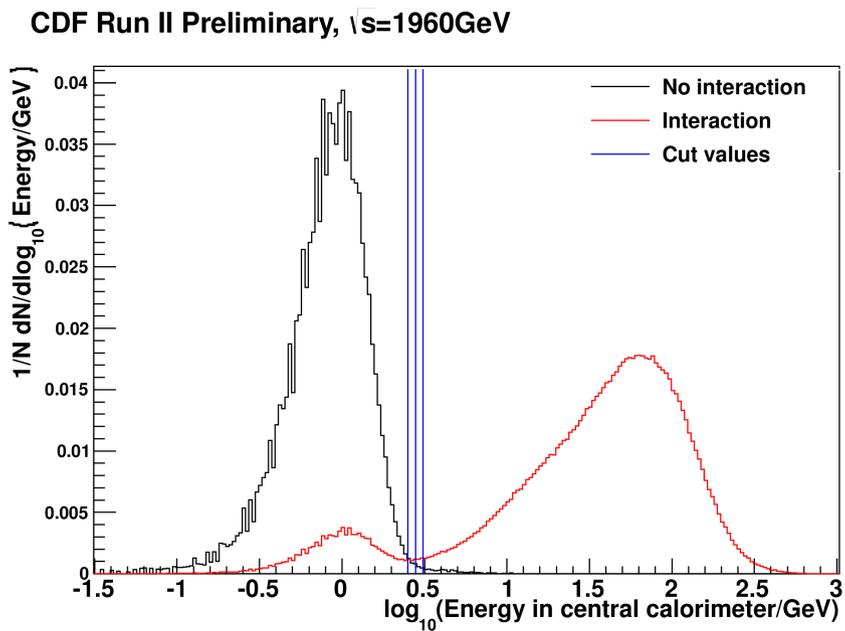
CDF Run II Preliminary,  $\sqrt{s}=900\text{GeV}$



CDF Run II Preliminary,  $\sqrt{s}=900\text{GeV}$



# Central calorimeter

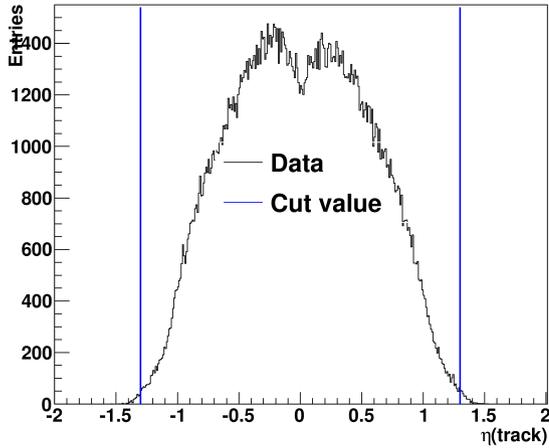


# 2 Exclusive tracks: additional cuts

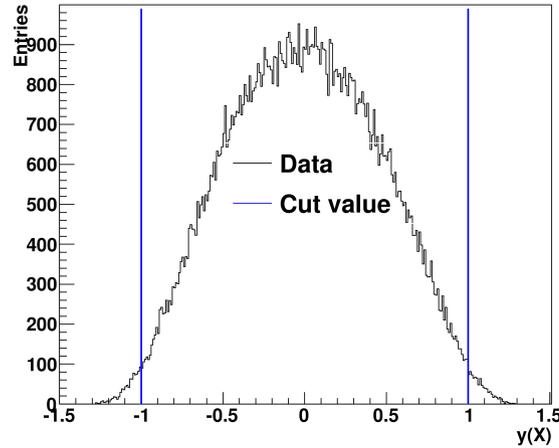
CUTS		Variations for systematics estimation
• Track Eta	$< 1.3$	1.297 – 1.303
• Central state rapidity	$< 1.0$	0.998 – 1.002
• Number of muons	$= 0$	No systematics
• 3D opening angle	$< 3.1$ rad	3.09 – 3.11
• Track D0	$< 0.1$ mm	0.095 – 0.105 mm
• Track Pt	$> 0.4$ GeV/c	0.39 – 0.41 GeV/c
• Tracks matching triggered towers		No systematics
• $\Delta Z0$	$< 1.0$ cm	0.8 – 1.2 cm
• $ Z0 $	$< 60$ cm	59.85 – 60.15 cm
• COT Axial hits	$\geq 25$ hits	24 – 26 hits
• COT Stereo hits	$\geq 25$ hits	24 – 26 hits
• Track $\chi^2/Ndof$	$< 2.5$	2.4 – 2.6
• Total charge	$= 0$	No systematics

# Cuts and variations (1)

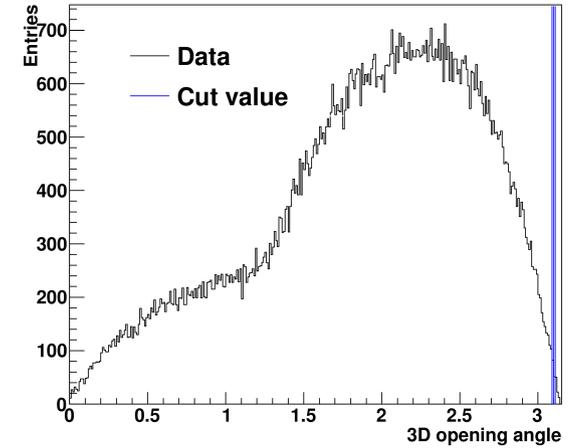
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



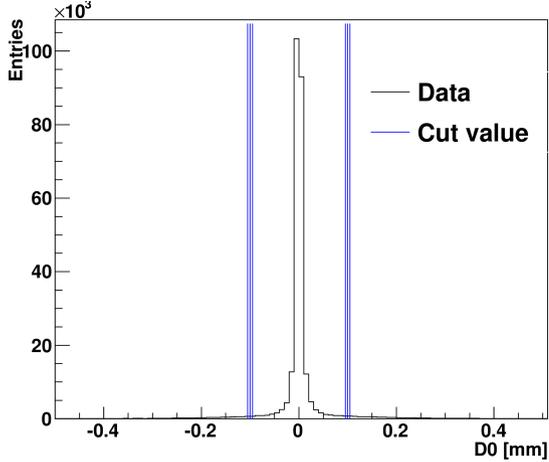
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



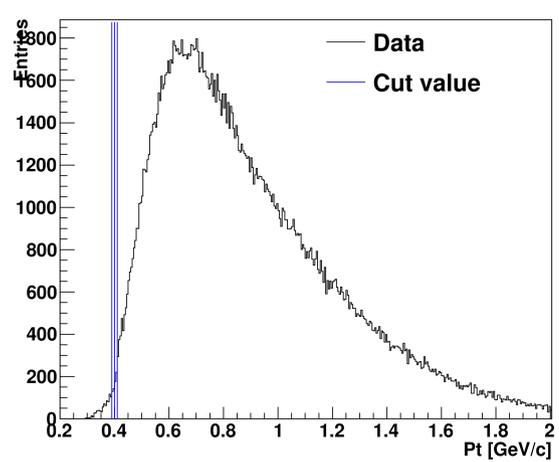
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



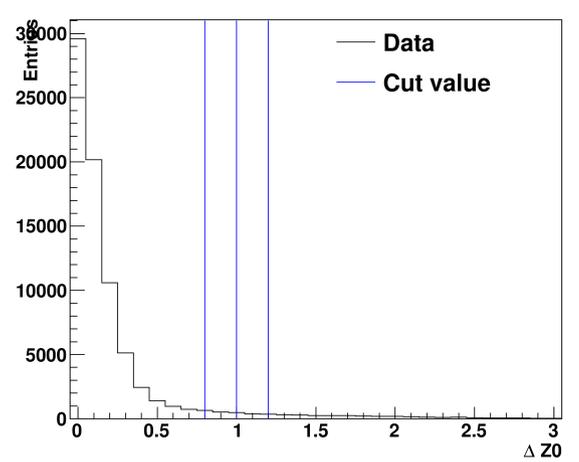
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV

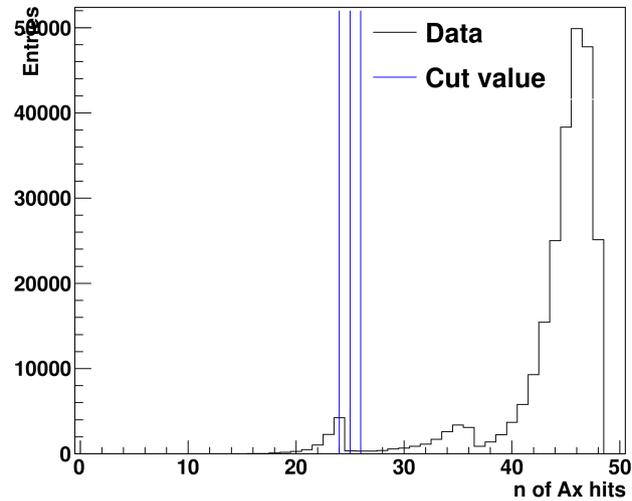


CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV

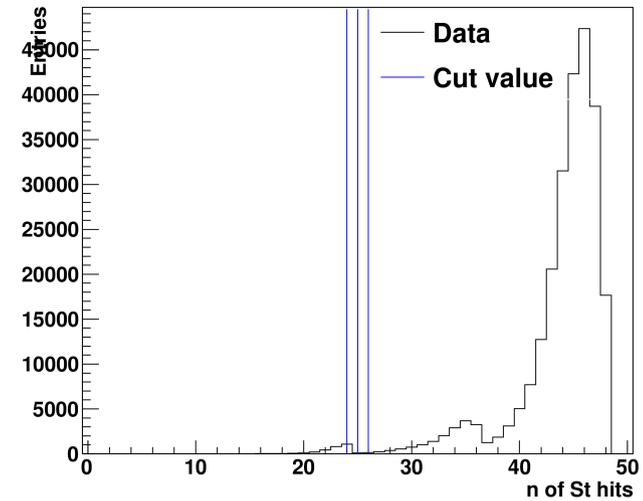


# Cuts and variations (2)

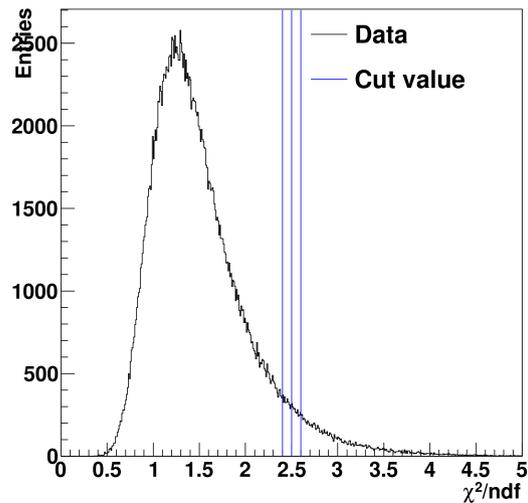
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



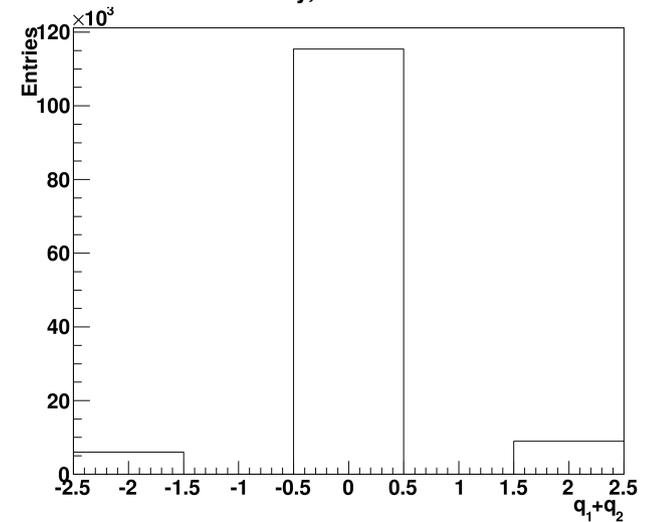
CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV

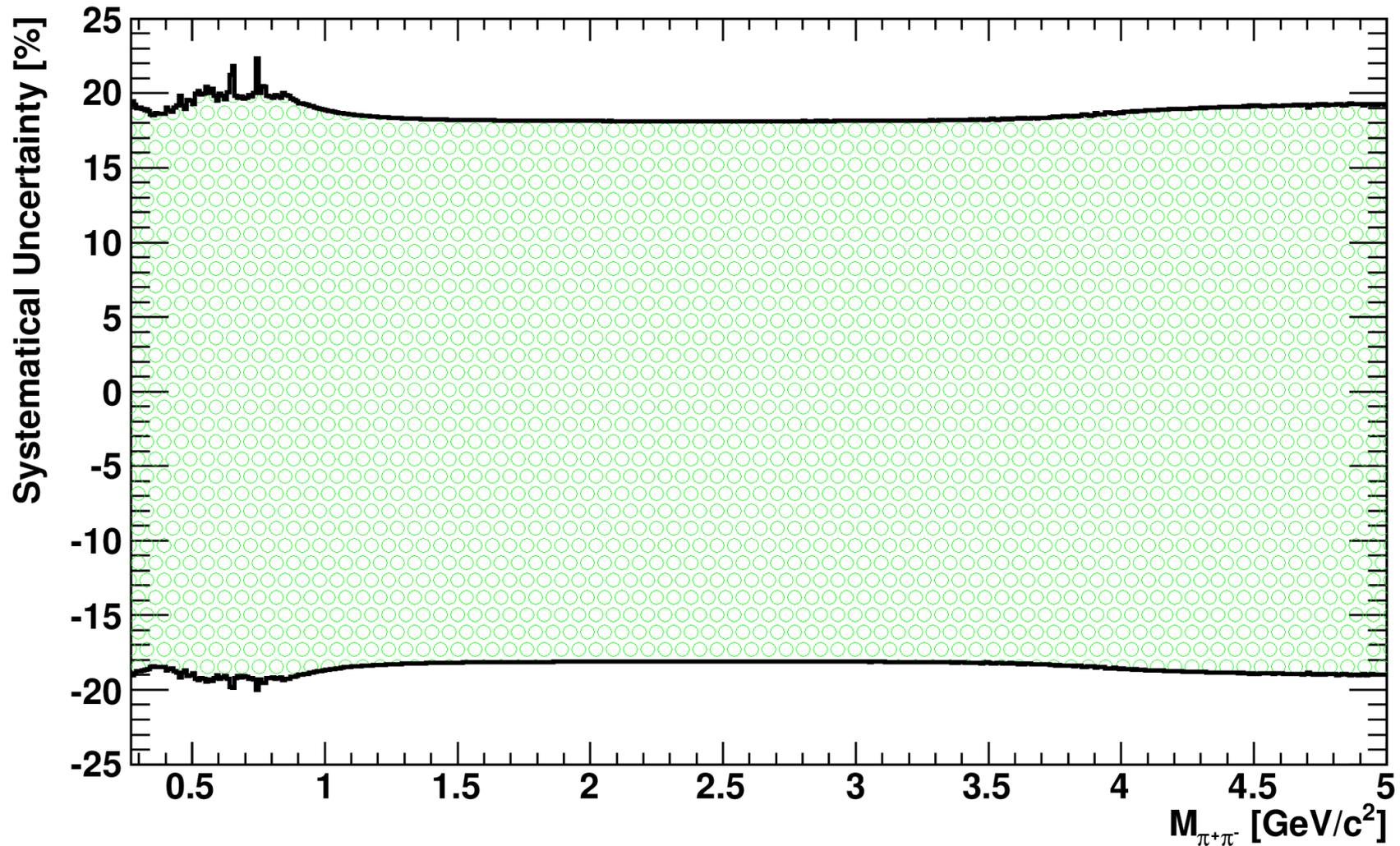


CDF Run II Preliminary,  $\sqrt{s}=1960$  GeV



# Systematics 1960

Systematical uncertainties,  $\sqrt{s} = 1960$  GeV



# Systematics 900

